ARCHITECTURUS TO HIS SON.

THE LAMP OF SCIENCE.*

If I describe the science of the architect as that which forms the great power of the civil engineer, this will convey to your mind my meaning so far by illustration. It consists of the two departments,—firstly, the philosophy of natural structure of materials involved in building: and secondly, the philosophy of the constructive principles of building. There is included by implication in each of these departments, as part of the idea of the question of building, the philosophy of the operations of nature in connection with building. "Construction," says Mr. Donaldson in his "Maxims," "has for its laws the principles which govern matter: for materials, the productions of the vegetable and mineral worlds; and for its end resistance to weight, a successful struggle with the elements, and victory over decay."

It would take a volume rather than a page to exhibit these philosophies of which I speak. There is no lack of treatises on all their details: my purpose is but to indicate the position of the subject among the objects of the architect's attainment, and to force upon your attention the folly of its neglect.

The practical architect, then, ought, in the first place, to be well versed in the knowledge of building materials, as regards their natural structure and mere application; and not only, mark me, in their *knowledge*, but in their *philosophy*,—in that knowledge systematised as a science. But I must disclaim the position with which an enthusiast might complicate the question—that such philosophy is equal to the comprehension of all that is to be learnt in mineralogy, vegetable physiology, geology, chemistry, and the like. These sciences are every one of far wider range than merely as they bear upon building; and it is only as they bear upon building that the architect requires their knowledge, as the master of the builder. But so far he ought to know them thoroughly.

Being thus possessed of the knowledge of the properties and applications of the several materials in his hands, he must, in the second place, understand the science of the uses and employments in detail of these materials,—that is to say, the requirements of building, and the mechanical means of meeting those requirements with the materials in hand. I might say, if I were humorous, that there are three ways of meeting those requirements. A late eminent statesman, as all the world has heard, had a habit of stating that there were three courses open to him; and in our own subject, an eminent professor takes pleasure in elucidating a triplicity in the essence of things—three gradations of proportion, three gradations of strength, three primitive colours, three degrees of comparison, three positions of time, three elements of the crust of the earth, three orders of architecture, and (no doubt he would say) three lamps likewise of architecture, where Mr. Ruskin and your old father see seven. So be it, then, and there are also three ways of meeting the requirements of building with the materials at command; first, by over-building; secondly, by under-building; thirdly, by well-building: first, with excessive substance; secondly, with insufficient substance; and thirdly, with exactly adjusted substance. I need not say, that of these the third must be the architect's aim. The first is waste or unwieldiness, the second ruin inevitable, and the third science. To calculate absolute equilibrium is the perfection of science in theory: to build with sufficient excess, and no more, to ensure permanent stability, is the perfection of science in practice—that upon which the third lamp shines.

I need not be careful in discriminating between science and building, as if I were writing a treatise on these subjects; and a great deal of what passes through my mind as I write I therefore do not record, but leave to pass through yours as you read. But it may be well to hold what I call science to comprehend only the philosophy of the mechanics of structure, and to include under the head of building all other matters of knowledge of the builder's work. And this, perhaps, I ought to have said before.

The materials of mechanical construction hitherto have been stone (or brick) and timber, to which a third is now of late added—iron. The works of the ancient times, those of the mediæval ages, and those of the modern period and our own day, are familiar to you, and their scientific merits and demerits have often been canvassed in theory, so that the general principles of science in the abstract are by no means unknown; besides which there has been within the last century such great advance attained in the experimental and scientific investigation of all such subjects, and so many elaborate and explicit treatises have been issued from the press of this and other countries; and, moreover, in the works of our engineers there has been displayed so close a comprehension of scientific perfection, and such ingenious precalculations and satisfactory results; that the cause of the well-known deficiencies of the architects of our day is only matter of wonder. Certainly while there exists, and in such universal estimation, another profession, whose attention is specially absorbed in the execution of great scientific constructions, it is scarcely matter of surprise that architects, having only to do with smaller works, and having their attention, moreover, specially distracted in the complicated nature of their calling, should fail to maintain, and indeed, fall very far behind, the standard of the engineer's skill in the abstract; but surely there can be no reason why the architect should not, in his own comparatively simple province, at least maintain creditably the standard of his profession in other times. But I believe it is the fact that, with a very few exceptions, men of our profession are scarcely at all, even in theory, acquainted with the principles on which, for instance, the Freemasons equipoised their system of arcuation, while in practice there is almost nothing of these principles carried into effect—perhaps never a single calculation made further than by reference to such a thing as a book of precedents, the Building Act, or the requirements of a body of commissioners. So long as Tredgold is on the bookshelf, or even Peter Nicholson, we need never be at a loss for such a matter as the scantlings of a girder, or of a roof-principal of standard truss and span, or of even a cast-iron beam or a story post; but this manner of overcoming difficulties will not suffice much longer. We must again acquire the power of precalculating for the occasion, whether for stone arch, pier, abutment, pinnacle, or buttress, for timber trussing of whatever complexity or peculiarity, for iron, cast in pillar, beam, rafter, strut, or rib, or wrought in tie or suspension rod, and for brick even in the common wall, pier, aperture, or arch. Some of the architects of the dark ages, no better than friars, could estimate and adjust, and did do so, as we every day can see, with a precision amounting to mathematical certainty, the most complicated questions of elaborated counterpoise, raising up structures of magnitude and complexity yet astonishing, with materials little better than the paving stones of the French barricades, almost realising Mr. Donaldson's maxim of the "ablest constructor" who upholds upon the smallest amount of surfaces of support, the greatest weight, with strength uniting economy, till we almost fancy it is but a painted vision that is before us—the picture of some dream of magic grottoes woven in wicker-work. Too nicely, indeed, had their adjustment been sometimes done, where crumbling ruins are now all that remain of beautiful building — traceried window, sculptured foliage, and fan-vault like the forest sky. And why cannot we, of this enlightened time, sitting in purple and fine linen in libraries over-loaded with dissertations, precedents, experiments, statistics, data, formulæ and tables, encyclopædias, and indices, do as did those poor men of sackcloth and mortification, spelling with difficulty through their little store of scanty gleanings from an untilled field? Ah! my son, those men, I dare say, learned in a severer school than ours, and burned the midnight oil in patient study, while cigar divans and latch-keys were as yet unheard of.

While I cannot agree with those who demand that the civil engineer shall acknowledge himself a usurper, and give up his territory to the architect as its rightful ruler, believing as I do that this dissection of an ancient unity is but a profitable application of the principle of the division of labour—profitable both to the interest of the community and to the real interest of architecture; yet there is one matter which seems now to be acknowledged as the concern of the engineer, of which I should be disposed to dispute with him the possession as a question of right,—and that matter is the bridge. In the different varieties of the bridge we have unquestionably an excellent series of subjects for architectural effect of the highest order and most piquant degree. I incline to the opinion, moreover, that the architectural treatment of the bridge is a thing which has never yet been fairly attempted—whether it be the stone arch, the iron rib, or the suspended way,—not to speak of the tubular wonders of our own period, which seem to bear more of the appearance of the coffin of some such thing as a sea serpent, than of that artistic effect of which their construction is perfectly capable. Why I claim the bridge for the architect is, that I assume the impossibility of the engineer ever becoming an artist, seeing that, with perhaps at present this single exception, there is nothing in his province which is a subject for art. And therefore, unless there be an amount of mechanical difficulty which is beyond the reach of the architect, this particular subject would be better handled by him. And instead of the subject involving extraordinary difficulty, I think the case is the reverse—that the philosophy of the bridge is rather simple. If in the case of the new bridge of Westminster the system of public competition should be resorted to (a system as profitable in works of great public importance as it is pernicious in its present extension to every trumpery nicknack in a country village), then I hope the architects of England will come forward in strength and determination, to match the engineers in simple skill, and draw them from the field on the question of the beautiful—that without which, within its own wide sphere, man's work is unworthy of him.

I have little more to say on science, but that we must not forget those knowledges which refer to the operations of nature on construction, from the philosophy of the foundation on which it is to stand to that of the action of the elements in the work of decay. This department completes the question of Science; and what else I have to say on practical matters must be attended to under the question of building.

I have spoken of Art as a prodigiously noble thing: I speak now of Science as very noble too. There are pretended men of science whom I despise,—talkative, fussy, and conceited men, whose shallow waters are in perpetual boil, while the deep stream runs silently and slow. Empirics, too, I hold beneath contempt,—blind leaders of the blind,—much more pernicious than profitless. But the clear-headed, calculating man, who can grasp nature's agencies like arrows, and direct them with unerring aim—who can deduce and demonstrate, discover and detect by system and rule—who can direct me from the end to the beginning, from the beginning to the end,—such a man is an enchanter, a prophet, a worker of miracles. When Le Verrier wrote to his friend to look towards such a spot in the stupendous heaven at such a time, and see an unseen planet rolling by—"I have not seen it," says he, "but it will be there"—what do you call such a man? When in his silent study, while plodding traders crept by along the street absorbed in finance, and gilded butterflies were fluttering on the promenade absorbed in finery, this lonely man, with pen and paper, was absorbed in such a thing as this,—what would your traders and your butterflies have thought of him? But he has done,—the last figure finishes his work,—and makes his name immortal: he has weighed that unseen planet in scales,—he has measured

* See p. 761, *ante*.